ABSTRACT

The invention provides a process capable of providing elongated nanostructures conformably aligned perpendicular to the local surface, while also allowing control over the diameter, length, and location. The process also permits controllably introducing defects at desired locations along the length. Conformably aligned straight sections are grown under the influence of an electrical field and curly defect regions are grown after switching off the field. A preferred embodiment uses high frequency plasma enhanced chemical vapor deposition (PECVD), typically with microwave-ignited plasma. The extraordinarily high extent of conformal alignment - on both flat and non-flat surfaces - appears to be due to the electrical self-bias imposed on the substrate by the plasma, the field line of which is perpendicular to the substrate surface. In addition to the conformal orientation, it was found that by selecting a particular thickness for the catalyst layer, it was possible to obtain nanotubes of a desired diameter, while the length of the nanostructure is determined by the duration of the PECVD process. And, by patterning the catalyst metal, it is possible to form nanostructures in particular locations on a substrate.